S4 RESCUE SART

Search And Rescue Transponder

User Guide

CONTENTS

Warnings **1**
General description **2**
SART principle of operation **2**
Installation **4**
SART General Assembly **5**
Operating instructions **6**
Self test facility **7**
Battery replacement **7**
Technical description **8**
Function chart **8**
Fault Finding **8**
Servicing **8**
Dimensions **9**
Operation of marine radar for SART detection **10**
Radar Range Scale 10
SART Range Errors 10
Radar Bandwidth 10
Radar Side Lobes 10
Detuning the Radar 10
Gain 10
Anti-Clutter Sea Control 11
Anti-Clutter Rain Control 11
Technical Specification **12**
Declaration of Conformity **13**
Limited Product Warranty **15**

Warnings

- **This SART is an emergency device for use only in situations of grave and imminent danger.**

- **False alarms cost lives and money. Help to prevent them; understand how to activate and disable your equipment.**

- **Read the complete manual before installing, testing or using the SART.**

- **The SART contains no user servicable parts. Return to your dealer for service.**

- **Dispose of this device safely. Contents include Lithium batteries; do not incinerate, puncture, deform or short-circuit.**

- **This device emits radio frequency radiation when activated. Because of the levels and duty cycles, such radiation is not classed as harmful. However, it is recommended that you do not hold the radome while the SART is activated.**

- **If the security tab is broken, the SART is not compliant with SOLAS regulations and must be repaired or replaced.**

Transportation

Because it contains a primary non-rechargeable Lithium battery, the SART may have special transportation requirements depending on local and international regulations in force at the time.

The battery pack contains 6.2g Lithium in total. Transport the SART in compliance with applicable regulations for this mass of hazardous material.

For further information refer to the McMurdo website *www.mcmurdo.co.uk*

General description

The SART (**S**earch **A**nd **R**escue **T**ransponder) is designed for survivor location during search and rescue operations.

CARRY-OFF SART

Supplied as one integral unit. This is normally mounted in a bulkhead bracket (supplied) which is used to stow the unit on the mother vessel. On abandoning to a survival craft the SART can be carried in one hand off the stricken vessel and mounted through a port in the canopy of the survival craft using the telescopic pole.

The main body of the SART is high visibility orange thermoplastic, attached to the sealed replaceable battery pack by stainless steel fastenings. The joint is sealed against water ingress by an O-ring.

Operation is by a rotating switch ring providing ON, OFF and TEST functions. The ON position is reached by breaking a security tab. The switch ring is spring loaded so that it returns automatically from the TEST position.

The Lithium battery is fitted with internal overload protection and has a five year storage life. Non-reversible electrical connections are provided in the SART body and battery pack to facilitate battery replacement.

Each SART carries a unique serial number on the label on the orange body.

LIFERAFT SART

Supplied with or without mast. Normally is packed as part of the liferaft equipment. The mast version is mounted in the same manner as the carry-off version; the version without the mast is intended to be hung from the highest point inside the liferaft.

The SART itself is identical with the carry-off version.

SART principle of operation

Actuating a SART enables a survival craft to show up on a search vessel's radar display as an easily recognised series of dots.

RADAR (radio detection and ranging) is a device carried by most ships which is used to determine the presence and location of an object by measuring the time for the echo of a radio wave to return from it, and the direction from which it returns.

A typical ship's radar will transmit a stream of high power pulses on a fixed frequency anywhere between 9.2GHz and 9.5GHz. It will collect the echoes received on the same frequency using a display known as a Plan Position Indicator (PPI), which shows the ship itself at the centre of the screen, with the echoes dotted around it. Echoes further from the centre of the screen are thus further from the ship and the relative or true bearing of each echo can be easily seen.

The SART operates by receiving a pulse from the search radar and sending back a series of pulses in response, which the radar will then display as if they were normal echoes. The first return pulse, if it sent back immediately, will appear in the same place on the PPI as a normal echo would have done. Subsequent pulses, being slightly delayed, appear to the radar like echoes from objects further away. A series of dots is therefore shown, leading away from the position of the SART. This distinctive pattern is much easier to spot than a single echo such as from a radar reflector. Moreover, the fact that the SART is actually a transmitter means that the return pulses can be as strong as echoes received from much larger objects.

A complication arises from the need for the SART to respond to radars which may be operating at any frequency within the 9GHz band. The method chosen for the SART is to use a wideband receiver (which will pick up any radar pulses in the band), in conjunction with a swept frequency transmitter. Each radar pulse received by the SART results in a transmission consisting of 12 forward and return sweeps through the range 9.2GHz to 9.5GHz. The radar will only respond to returns close to its own frequency of operation (ie. within its receive bandwidth), so a "pulse" is produced at the radar input each time the SART sweep passes through the correct frequency. The text and diagrams on Pages 10 & 11 show this in more detail.

A slow sweep would give the radar a stronger echo to deal with as the sweep would be inside the operating bandwidth for a longer period. The delay for the sweep to reach the operating frequency may however lead to an unacceptable range error, as delayed echoes appear to be coming from more distant objects.

To minimise this problem, the SART uses a "sawtooth" response, sweeping quickly, then slowly for each of its twelve forward and return sweeps. At long range, only the slow sweeps, giving the strongest returns, are picked up. At close range, where errors are more important, the fast sweeps are also detected. As the first sweep is a fast one, then the range error is minimised and should be less than 150 metres.

The timescale over which all this occurs is very short. Each "fast" sweep takes about 0.4µs, each "slow" sweep about 7.5µs. The complete series of twelve forward and return sweeps is therefore complete within 100µs. Displayed on the PPI, the spacing between each pair of dots will be 0.6 nautical miles.

On a long range setting, a typical radar will be triggering the SART every millisecond - but only during the period that the rotating radar scanner is pointing in the correct direction. Most modern radars use sophisticated noise rejection techniques, which prevent the display of echoes which are not synchronized with the radar's own transmissions, so one radar will not normally be confused by a SART's response to a neighbouring radar.

The SART indicates that it has been triggered by lighting an indicator LED continuously (it flashes in standby mode) and by sounding an integral buzzer. If no radar pulses are detected for a period exceeding 15 seconds, the SART reverts to "standby" mode.

Installation

The preferred mounting location is inside the vessel, and protected from the elements, usually on the ship's bridge wing. The SART should be mounted where it will not get in the way of day-to-day operations, but where it can readily be accessed near an emergency exit in the event it is needed.

Do not install the SART within the ship's radar beam.

Fix the mounting bracket to a bulkhead in a convenient location. The recommended fixing is by M5 marine grade stainless steel (eg A4/316) bolts; length is dependent upon application. The bolts should be secured with either stainless steel locking nuts or stainless steel nuts with stainless steel shakeproof washers.

Mount the SART, dome uppermost, onto the bracket by locating the lugs on the SART pole mount into the slots in the bracket. Push down the SART into place.

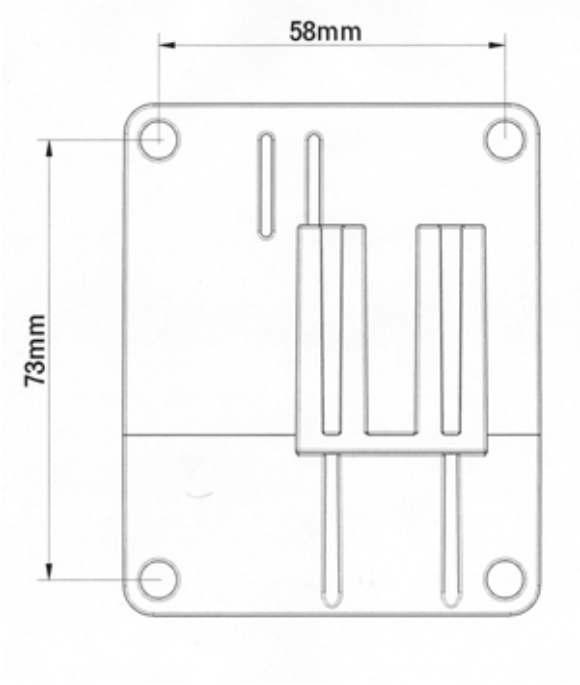

Figure 1
Bracket mounting holes: 4 holes, 5.5mm diameter

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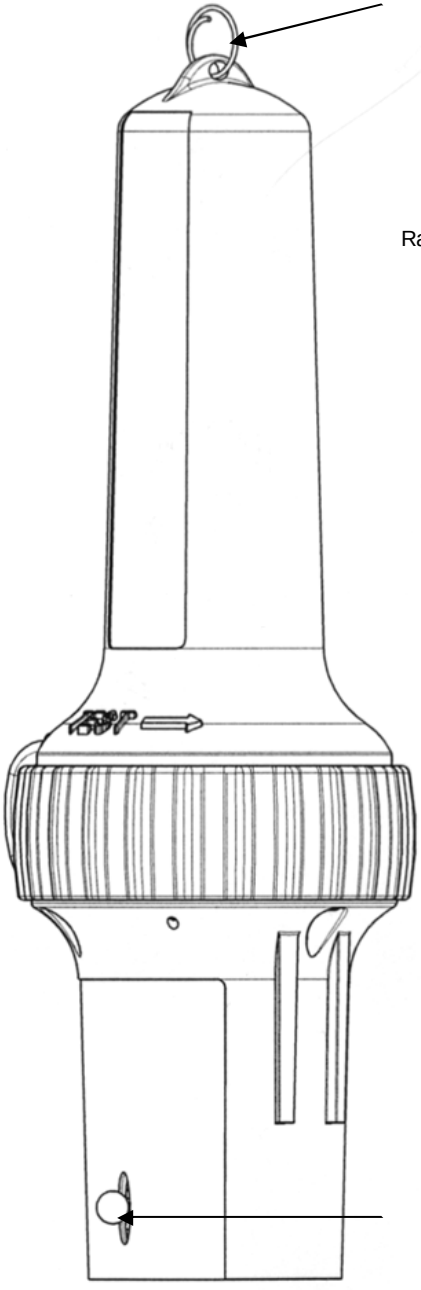
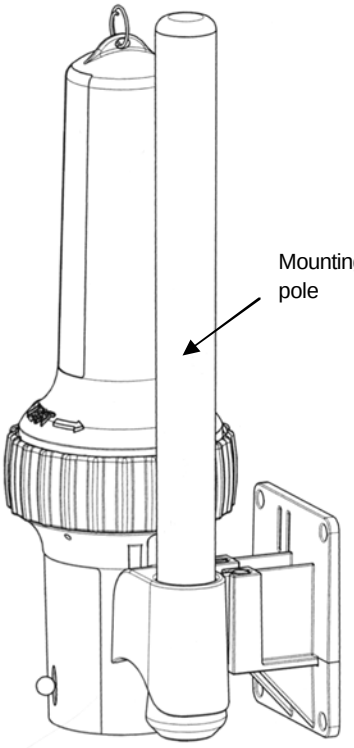
NOTE: Safe compass distance 1.5m.

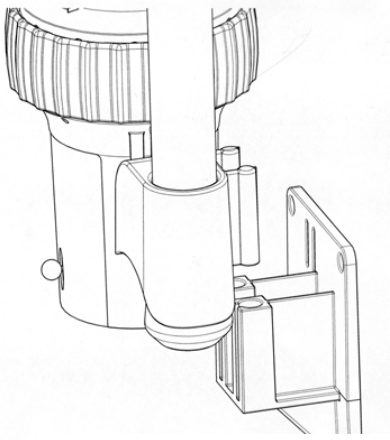
SART General Assembly



Radome



Mounting pole



Bulkhead Mounting bracket

Operating instructions

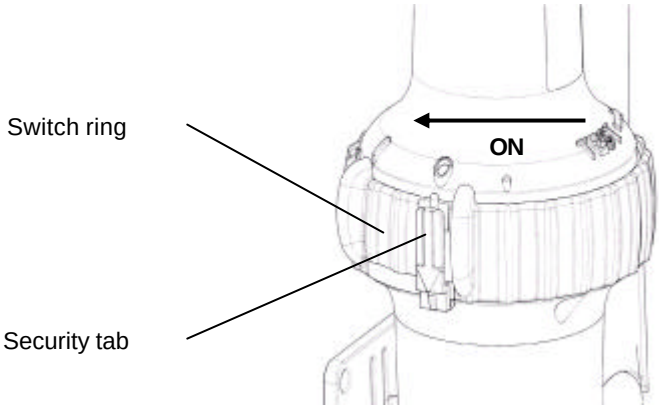
Remove from bulkhead bracket:

Release clip and lift SART from bracket

To switch on:

Break the security tab away from the body of the SART

Rotate the switch ring clockwise (ie to the left) to the ON position marked by “1”



To extend the telescopic pole:

1. Grasp rubber cover at bottom of pole, and twist the pole to release it in the pole mount. Pull the pole down and twist to lock in place in the pole mount
2. Remove rubber cover from bottom of pole; allow pole sections to drop. Lock sections together by twisting each section.

To deploy in a survival craft (liferaft):

Extend the SART supporting pole as detailed above

Tether the SART to a suitable point using the lanyard which unwinds from its base.

Inset the SART through the port in the canopy

Position the bottom of the support pole in the antenna pocket

Secure the pole to the canopy support.

Some survival craft have the SART already packed as part of the inventory. In general, these models of SART are not fitted with the support pole. The SART should be switched ON then suspended by its top loop from the highest point of the survival craft.

If the lanyard becomes unwound, it may be rewound by rotating the spool in the base of the SART in the direction of the arrow.

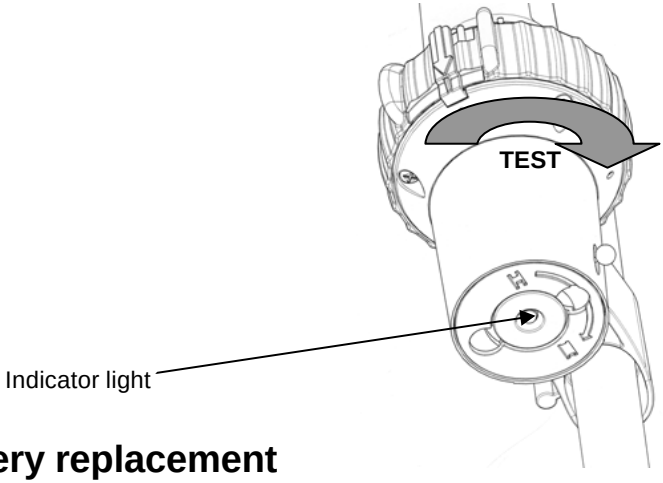
Self test facility

Regular testing of the SART is advised. The duration of the test should be limited to as short a time as possible as the SART response may be received by other vessels which are within range.

There are no operational differences between TEST and ON modes; the rotary switch must be held in the TEST position, on release it returns to the OFF position.

1. Ensure compliance with all applicable Health and Safety instructions when working in proximity to a radar transmitter.
2. Locate the SART within the line of sight of an operating approved marine Radar.
3. Rotate the switch ring anticlockwise (ie to the right) to the TEST position, and hold it in this position.
   a) If the SART responds to the radar, the red light in the base of the SART will be continuously lit and the buzzer will sound every 2 seconds.
   b) If the SART does not respond to the radar, the red light will flash every 2 seconds and the buzzer will not sound.

   The SART must respond to the radar to pass the test.
4. Switch off the SART by releasing the switch ring; check that it returns fully to the OFF position.
5. During the annual survey, perform the self test and verify the SART performance by observing the response on the radar.



Battery replacement

The battery should be changed 5 years from the date of manufacture shown on the label or after use.

It is recommended that battery change should only be performed by an authorised McMurdo service agent, in order that a complete assessment and integrity check can be performed. The replacement battery kit is McMurdo part number 86-630 and contains all necessary components.

Technical description

A single switched antenna is used for both receive and transmit functions; the switch normally connects the antenna to the receiver circuit. In the standby state only the receiver portion of the SART is powered to reduce battery consumption to a minimum. In this condition the indicator circuit causes the LED to flash once every two seconds.

On receipt of a radar pulse the video amplifier and detector circuit causes the rest of the circuitry to become active and the unit switches to transmit mode. In this condition the indicator circuit causes the LED to remain steady and the buzzer to sound every two seconds.

The detection of a radar pulse causes the switch to connect the antenna to the transmitter circuit. The output stage is fed by a Voltage Controlled Oscillator (VCO), whose frequency is determined by a sweep generator. When triggered by the detector the sweep generator turns on the VCO and causes it to produce exactly 12 forward and reverse frequency sweeps before shutting down again.

If no radar pulses are detected for a period of 15 seconds the unit reverts to standby mode.

Function chart

SART STATUS	BUZZER	RED LED
OFF	OFF	OFF
STANDBY MODE (TEST or ON)	OFF	FLASHING EVERY 2 SECONDS
ACTIVELY TRANSPONDING (TEST or ON)	ON EVERY 2 SECONDS	ON

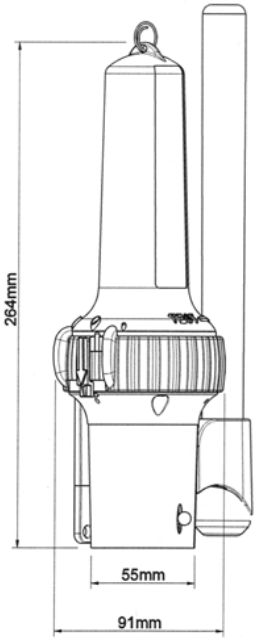
Fault Finding

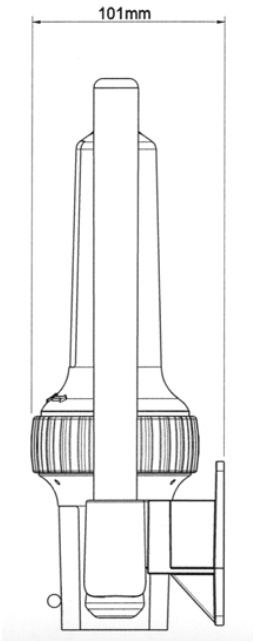
Fault finding is limited to performing the self test and verifying the SART response on the radar.

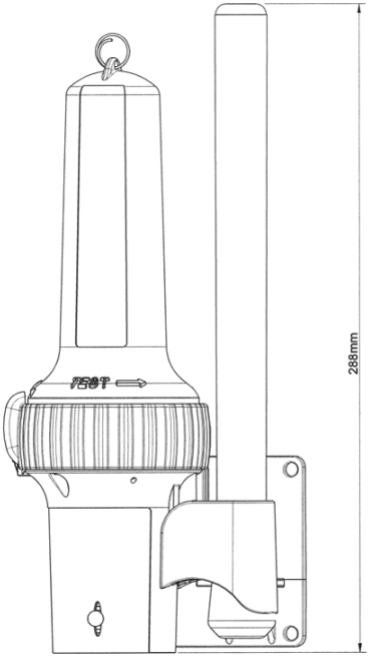
Servicing

The SART contains no user-serviceable parts, and consequently should be returned to an authorised McMurdo service agent for repair. Ensure compliance with the appropriate regulations for transportation of Lithium material, as detailed in the Transportation section on the front inside cover.

Dimensions







Operation of marine radar for SART detection

Radar Range Scale

When looking for a SART it is preferable to use a range scale between 6 and 12 nautical miles. This is because the spacing between the SART responses is about 0.6 nautical miles (1125 metres) and it is necessary to see a number of responses to distinguish the SART from other responses.

SART Range Errors

There are inherent delays in the SART responses; the SART has a trigger delay and may also have to sweep through the whole radar band before reaching the frequency of the search radar. At medium ranges of about 6 nautical miles the range delay may be between about 150 metres and 0.6 nautical miles beyond the SART position. As the SART is approached the radar delay of the first dot should be no more than 150 metres beyond the SART position.

Radar Bandwidth

This is normally matched to the radar pulse length and is usually switched with the range scale and the associated pulse length. Narrow bandwidths of 3.5MHz are used with long pulses on long range and wide bandwidths of 10-25MHz with short pulses on short ranges. Any radar bandwidth of less than 5MHz will attenuate the SART signal slightly so it is preferable to use a medium bandwidth to ensure optimum detection of the SART. The Radar operating manual should be consulted about the particular radar parameters and bandwidth selection.

Radar Side Lobes

As the SART is approached side lobes from the antenna may show the SART responses as a series of arcs or concentric rings. These can be removed by the use of the anti-clutter sea control although it may be operationally useful to observe the side lobes as these will confirm that the SART is near to the ship.

Detuning the Radar

To increase the visibility of the SART in clutter conditions the radar may be detuned to reduce the clutter without reducing the SART response. Radar with automatic frequency control may not permit manual detuning of the equipment. Care should be taken in operating the radar detuned, as other wanted navigational and anti-collision information may be removed. The tuning should be returned to normal operation as soon as possible.

Gain

For maximum range SART detection the normal maximum gain should be used.

Anti-Clutter Sea Control

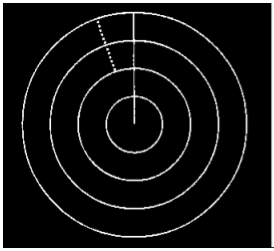
For optimum range SART detection this control should be set to the minimum. Care should be exercised as targets in sea clutter may be obscured. Some radar sets have automatic/manual anti-clutter sea control facilities in which case the operator should switch to manual.

Anti-Clutter Rain Control

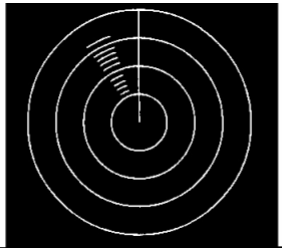
This should not be used when trying to detect SARTs as the SART responses may be removed by this control. Some sets have automatic/manual anti-clutter rain control facilities in which case the operator should switch to manual.

Radar Displays

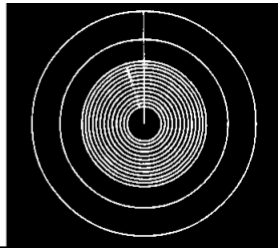
These sketches show the appearance of a SART response at different ranges.



SART response from distant liferaft (5-6 miles)



SART response from liferaft at medium range (2-3 miles). Note widening of "echos"



SART response close to vessel (<1 mile). Display now shows "rings" caused by strength of signal

Technical Specification

FREQUENCY:	9.2GHz - 9.5GHz
POLARIZATION:	Horizontal
SWEEP RATE:	5μs per 200MHz nominal
RESPONSE SIGNAL:	12 sweeps
FORM OF SWEEP:	Forward: 7.5μs ± 1μs
	Reverse: 0.4μs ± 0.1μs
PULSE EMISSION:	100μs nominal
EIRP:	>400mW (+26dBm)
RX SENSITIVITY:	Better than –50dBm (0.1 mW/m^2) (Note 1)
DURATION:	96 hours in standby condition followed by a minimum 8 hours of transmission while being continuously interrogated with a pulse repetition frequency of 1kHz.
TEMP RANGE:	Operating: -20^{0}C to +55^{0}C
	Storage: -30^{0}C to +65^{0}C
RECOVERY TIME:	Following excitation: 10μs or less
ANTENNA HEIGHT:	Greater or equal to 1m (Note 2)
RESPONSE DELAY:	0.5μs or less
ANTENNA BEAM:	Vertical: +/-12.5 degrees
	Azimuth: Omnidirectional to +/-2dB
WEIGHT:	SART only: 360g SART + pole: 510g SART complete: 530g
DIMENSIONS:	Overall, in bracket: 283 x 101 x 90mm
BUOYANCY:	Buoyant

Note
1. Effective receiver sensitivity includes antenna gain.
2. The effective antenna height applies to equipment required to meet Regulation 6.2.2 of Chapter III and 7.1.3 and 8.3.1 of Chapter IV of the 1988 Amendments to the 1974 SOLAS Convention.

Standards

Complies with IMO Resolution A.802(19)

Test and Approval Standards are specified on the Declaration of Conformity following.

Declaration of Conformity

Silver Point
Airport Service Road
Portsmouth
Hampshire UK
PO3 5PB
Int + 44 (0)23 9262 3900
www.mcmurdo.co.uk

mcmurdo

EC DECLARATION OF CONFORMITY

The following products comply with the essential requirements of Council Directive 96/98/EC on the approximation of the laws of the member States relating to Marine Equipment as amended by Commission Directives 98/85/EC, 2001/53/EC, 2002/75/EC and 2002/84/EC, and by the application of an EC Type Examination Certificate as detailed overleaf.

Products covered by this Declaration

Product Type: **Search and Rescue Transponder (SART)**

Models: **McMurdo S4 RESCUE SART**
Sailor SART II
Skanti SART II
RFD S4 RESCUE SART

Intended usage of products
All vessels which must comply with IMO SOLAS regulations in coastal or International waters.

Surveillance conformity assessment is undertaken in accordance with Production Quality Assurance Module D by:

Lloyd's Register (No. 0038)
71 Fenchurch Street
London EC3M 4BS
United Kingdom

The product will carry this Conformity Marking:

0038
XX

Issued on behalf of McMurdo Limited

Signed :

Name: **C P Hoffman**
Title: **Technical Director**

Date: 30 NOV 2004

See overleaf for technical information

Page 1 of 2

Declaration of Conformity (page 2)

Technical Construction File held by:

McMurdo Limited
Silver Point, Airport Service Road, Portsmouth PO3 5PB UK

Regulations and Standards applied:

SOLAS74, as amended, Regulations III/4, III/6.2.2, IV/7.1.3, IV/14 and X/3
IMO Resolution MSC.97(73), 2000HSC Code, 8.2.1.2, 13.17.1, 14.7.1.3
IMO Resolutions A.530(13), A.694(17), A.802(19), A.813(19)
ITU-R M.628-3 (11/93)
EN 61097-1 (1993), IEC 61097-1 (1992), EN 60945 (2002), IEC 60945 (2002)

EC Type Examination Certificate:-

Name of Notified Body	**:**	**Lloyd's Register (No. 0038)**
Address of Notified Body	**:**	**71 Fenchurch Street, London EC3M 4BS, UK**
EC Type Examination Certificate :		**MED 0450285 05 October 2004**

ATTENTION

The attention of the specifier, purchaser, installer, or user is drawn to special measures and limitations to use which must be observed when the product is taken into service to maintain compliance with the above directive. Details of these special methods and limitations to use are available on request, and are also contained in the product installation and operator manuals.

BS EN ISO 9001, BS9000/CECC and CAA Approved
Registered in England No. 746603
Registered Office: 1650 Parkway, Whiteley, Fareham, Hampshire, PO15 7AH
VAT No: GB 421 1393 92

Limited Product Warranty

Subject to the provisions set out below McMurdo Limited warrants that this product will be free of defects in materials and workmanship for a period of 12 months from the date of purchase.

McMurdo Limited will not be liable to the buyer under the above warranty:-

- for any defect arising from fair wear and tear, wilful damage, negligence, abnormal working conditions, failure to follow McMurdo Limited's instructions (whether oral or in writing) including a failure to install properly and/or to use batteries recommended and/or supplied by McMurdo Limited, misuse or alterations or repair of the product by persons other than McMurdo Limited or an Approved Service Agent;
- for parts, materials or equipment not manufactured by McMurdo Limited in respect of which the buyer shall only be entitled to the benefit of any warranty or guarantee given by the manufacturer to McMurdo Limited;
- for the battery storage life which is specifically excluded from this warranty;
- if the total price for the product has not been paid.

McMurdo Limited does not make any other promises or warranties (express, implied or statutory) about the product except where the product is sold to a consumer in which case the statutory rights of a consumer are not to be affected.

In order to be valid, claims must be made under the above warranty in writing as soon as practicable after discovery of the defect or failure and within the warranty period referred to above. Proof of purchase will be required. The claim should be sent together with the product in question to the address set out below or to an Approved Service Agent.

Following a valid warranty claim McMurdo Limited shall be entitled to repair or replace the product (or part) in question free of charge, or at McMurdo Limited's sole discretion to refund to the buyer the price of the product (or a proportional part of the price). McMurdo Limited shall not be liable to a buyer who is not a consumer for any other loss or damage (whether indirect, special or consequential loss of profit or otherwise) costs, expenses or other claims for compensation which arise out of or in connection with this product. In the case of a consumer McMurdo Limited shall only be liable where other loss or damage is foreseeable.

Nothing shall limit McMurdo Limited's liability for death or personal injury caused by its negligence.

This warranty is to be interpreted under English law.

All enquiries relating to this warranty or Approved Service Agents should be sent to:

McMurdo Limited

Silver Point, Airport Service Road, Portsmouth, Hampshire, PO3 5PB UK
Telephone: Int + 44 (0) 23 9262 3900 Fax: Int + 44 (0) 23 9262 3998
Web: *www.mcmurdo.co.uk* Email: service@mcmurdo.co.uk

User Notes

This page contains no other data